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Memo

date: *February 17, 2009*

to: *RSC*

from: *D. Beavis* DB

subject: *Fault Study Results for EBIS Cable Penetrations*

Two fault Studies were conducted by C. Gardner for the three new penetrations that are intended to carry EBIS cables from the linac support building to the Booster enclosure. C. Gardner has documented the results of the LTB fault study[1], CA-222, and the booster beam fault study[2], CA-223. The results from these fault studies will be scaled to the Booster ASE and typical operating intensities. The results demonstrate that the area in the linac building is appropriately protected from potential beam faults in the booster enclosure.

LTB Faults

The Booster ASE for 200 MeV protons corresponds to $2.7*10^{18}$ protons per hour. The fault study was conducted on a valve near the penetrations. The dose rate measurement was taken at the wall where the penetration exits the concrete. This does not represent a whole body dose due to the small size of the penetration, 5 inch diameter penetration. Assuming a 45-degree half-opening angle for the exiting radiation and moving back a distance of 30 cm a reduction factor of 13.5 would be obtained for a whole body exposure. The results scaled to the booster ASE would be 68.5 rmem/hr with the entire beam lost on the valve. The present programs do not require intensities near the Booster ASE. A present nominal maximum intensity for the program is closer to $4.5*10^{15}$ protons per hour and a typical intensity for RHIC is on the order of $2.7*10^{14}$ protons per hour. Therefore, full beam faults in the LTB beam line near these penetrations should produced essentially no radiation outside these penetrations.

The valve represents a reasonably thick target at this beam energy. At higher energies the consideration of thicker targets would be necessary. Once cables are placed into the penetrations the dose rates due to beam faults would be greatly reduced. One of the penetrations may be a spare, but the dose rates are expected to be sufficiently low that placing material in the port does not seem warranted.

Booster Faults

The faults study for the booster beam was conducted in two parts. The first part had the beam strike the booster beam dump, B6. The two portion of the study moved the beam downstream of the beam dump trying to produce a beam fault near C4. More beam was lost at C3-C4 during the dumping at B6 rather than the second potion, which has a peak in the distribution at B8. Although the first study had a peak at B7, there was a distinct peak at C3-C4 representing about 25% of the beam. The fault study results will be compared to the prediction, but the comparisons should not be pushed too far.

The Booster ASE for 1.5 GeV protons is 3.6×10^{17} protons per hour. Scaling the fault study dose rate to the ASE level and for a whole body dose rate a dose rate of 37.3 mrem/hr is obtained. The second portion of the fault study would scale to a dose rate of 16 mrem/hr. As noted by C.J. Gardner[2] most of the beam faults between B6 and B8 for the first study although there is a peak near C4. This is farther away but at a more forward angle than the transverse prediction used by D. Beavis[3]. Figure 1.16 of Sullivan[4] will be used to compare a near zero degree fault at farther distance to a transverse fault close to the penetration. This crude comparison suggests that if all the beam could fault near the penetrations, that the faults dose rate would be 3 times higher. A similar number is obtained if it is assumed most of the radiation in the first study comes from the 25% beam lost in C3-C4.This number will be used in case there are any other machine modes that could cause the beam to fault closer to the penetrations. The table below summarizes the results for the scaled fault studies and the predictions, where the predictions have also been scaled to a whole body exposure.

Dose Rates for Full Beam Faults

	ASE (mrem/hr)	**Nominal upper limit 4.5×10^{15} p/hr**	**Typical RHIC 2.7×10^{14} p/hr**
LTB Fault Study	68.5	0.11	0.007
LTB Prediction	6000-180	9.6-0.3	0.6-0.02
Booster Fault Study	224	2.8	0.2
Booster Prediction	3750-115	45-1.5	3.4-0.1

Conclusion

The area in the linac support building near the penetrations is presently posted as a radiation area pending the review of the fault studies. In addition an alarming chipmunk was placed in the area pending review of the fault studies. It is concluded that the area can be posted as a Controlled Area-TLD required. This area of the building already has this posting for the linac and therefore other postings were not considered at this time. The chipmunk is not required for protecting the area. This year the chipmunk will remain in place to document dose rates in the area.

References

1. C.J. Gardner, "LTB Fault Study CA-222", January 26, 2009.
2. C.J. Gardner, "Booster Fault Study CA-223", January 26, 2009.
3. D. Beavis, "Cable penetrations into the Booster for EBIS", Oct. 9, 2008.
4. A.H. Sullivan, A Guide to radiation and radioactive Levels Near High Energy accelerators, Nuclear technology Publishing, 1992.

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RSC Booster File
RSC EBIS File
RSC Fault Study File
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